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ORIGINAL ARTICLE

SARS-CoV-2 infections and hospitalisations among immigrants in Norway-significance of occupation, household crowding, education, household income and medical risk: a nationwide register study

ANGELA S. LABBERTON[1], ANNA GODØY[1], INGEBORG HESS ELGERSMA[1], BJØRN HEINE STRAND[2,3,4], KJETIL TELLE[1], TRUDE ARNESEN[5], KARIN MARIA NYGÅRD[5] & THOR INDSETH[1]

[1]Division for Health Services, Norwegian Institute of Public Health, Norway, [2]Division of Mental and Physical Health, Norwegian Institute of Public Health, Norway, [3]Norwegian National Advisory Unit on Ageing and Health, Vestfold County Hospital Trust, Norway, [4]Department of Geriatric Medicine, Oslo University Hospital, Norway, and [5]Division of Infection Control and Environmental Health, Norwegian Institute of Public Health, Norway

Abstract

Background: As in other countries, the COVID-19 pandemic has affected Norway's immigrant population disproportionately, with significantly higher infection rates and hospitalisations. The reasons for this are uncertain. *Methods:* Through the national emergency preparedness register, BeredtC19, we have studied laboratory-confirmed infections with SARS-CoV-2 and related hospitalisations in the entire Norwegian population, by birth-country background for the period 15 June 2020 to 31 March 2021, excluding the first wave due to limited test capacity and restrictive test criteria. Straightforward linkage of individual-level data allowed adjustment for demographics, socioeconomic factors (occupation, household crowding, education and household income), and underlying medical risk for severe COVID-19 in regression models. *Results:* The sample comprised 5.49 million persons, of which 0.91 million were born outside of Norway, there were 82,532 confirmed cases and 3088 hospitalisations. Confirmed infections in this period (per 100,000): foreign-born 3140, Norwegian-born with foreign-born parents 4799 and Norwegian-born with Norwegian-born parent(s) 1011. Hospitalisations (per 100,000): foreign-born 147, Norwegian-born with foreign-born parents 47 and Norwegian-born with Norwegian-born parent(s) 37. The addition of socioeconomic and medical factors to the base model (age, sex, municipality of residence) attenuated excess infection rates by 12.0% and hospitalisations by 3.8% among foreign-born, and 10.9% and 46.2%, respectively, among Norwegian-born with foreign parents, compared to Norwegian-born with Norwegian-born parent(s). ***Conclusions:* There were large differences in infection rates and hospitalisations by country background, and these do not appear to be fully explained by socioeconomic and medical factors. Our results may have implications for health policy, including the targeting of mitigation strategies.**

Keywords: *COVID-19, SARS-CoV-2, immigrants, infection, hospitalisation, socioeconomic factors, medical risk*

Introduction

SARS-CoV-2 and COVID-19 have disproportionally affected ethnic minority groups in many countries, including the UK [1–5], the USA [6] and Scandinavia [7, 8]. Norway has thus far had relatively low rates of COVID-19. Since the first case in February 2020 and until 2 May 2021, there have been, per 100,000 population: 2113 confirmed cases, 78.6 hospitalisations, and 14.2 deaths [9]. Still, we too observed that the immigrant population has been hit disproportionately [10].

In 2021 foreign-born and Norwegians with foreign-born parents make up approximately 18.5% of Norway's population [11]. Since 1990, approximately

Correspondence: Angela S. Labberton, Norwegian Institute of Public Health, Postboks 222, Skøyen, 0213 Oslo, Norway.
E-mail: angelasusan.labberton@fhi.no

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one-third have migrated for employment, one-third for family reunification, one-fifth for protection and one-tenth for education [11]. Almost half of all foreign-born residents now originate from Europe (mainly Poland, Lithuania and Sweden), approximately one-third from Asia, 14% from Africa, and the remaining 5% from North and South America and Oceania [11]. Norway has relatively more labour migrants than Sweden and Denmark, especially since the expansion of the European Union in 2004 and, compared to Sweden, there are relatively fewer refugees [12]. Immigrants in Norway generally rate their own health as good, although there is great variation by country of origin and reason for immigration, with refugees having worse health compared to the other groups [13]. Furthermore, immigrants as a group report deteriorations in health at a younger age compared to non-immigrants [13].

Country background may be related to several factors affecting the risk of COVID-19 infection and/or hospitalisation, such as socioeconomic status, occupation and health disparities. However, there are few studies of how all these factors affect COVID-19 in immigrant populations, and most use broad ethnic categories. In the UK it appears that only part of the elevated risk of infection [1, 5], hospitalisation [2, 5] and death [5, 14, 15] can be explained by socioeconomic factors (varying definitions). In Norway, foreign-born persons more often live in the large cities, particularly Oslo, where infection rates have been high. In addition, they more often live in overcrowded housing and on average have lower incomes compared to Norwegian-born persons [11]. We have investigated whether such observable characteristics explain differences in infection and hospitalisation rates between persons with different country backgrounds.

This paper is based on a Norwegian-language report produced by the Norwegian Institute of Public Health (NIPH) in April 2021 [16]. It is important to disseminate more widely new knowledge that may help inform health policy, including targeting mitigation strategies towards the most affected groups, to help prevent hospitalisations and deaths from COVID-19.

Methods

The BeredtC19 Register is a national emergency preparedness register established during the COVID-19 pandemic (https://www.fhi.no/en/id/infectious-diseases/coronavirus/emergency-preparedness-register-for-covid-19/). BeredtC19 contains individual-level data, covering the entire Norwegian population, linked via the unique, personal identifier given to all Norwegian residents at birth or on immigration. The BeredtC19 data used for this study originated from the Norwegian Surveillance System for Communicable Diseases and laboratory database (all polymerase chain reaction (PCR) tests with test results for SARS-CoV-2), Norwegian Patient Registry and Norwegian Registry for Primary Health Care (hospital admissions, medical risk group), National Population Register (demographics, municipality of residence), Employer and Employee Register (occupation), and Statistics Norway (household crowding, education, household income).

See supplemental material for full methods and variable definitions. Briefly, household crowding is a predefined indicator variable and is present if the dwelling has fewer rooms than the number of residents (or one person in a one room dwelling), and the internal area is less than 25 m^2 per person. Highest education, available until 2019, was categorised into 'below upper secondary', 'upper secondary/vocational', 'university/college, short', 'university/college, long' and 'undisclosed/no education'. Persons less than 26 years old (N=1,606,768), may not yet have completed their education, and were coded into a separate category. Household income was recorded as annual household income after tax, divided by the number of consumptions units (EU scale) in the household and categorised in deciles. Medical risk groups are a defined set of 14 diagnoses or health conditions identified by the NIPH to convey a higher risk of severe COVID-19 (requiring hospitalisation), these groups are categorised as present or not. Persons with missing data for any explanatory variable were coded into a separate residual category for that variable and included in analyses, thus keeping the same sample for all analyses.

We studied two outcomes: laboratory-confirmed (PCR) infection with SARS-CoV-2, and hospitalisation with COVID-19. We compared residents firstly as three groups: (a) foreign-born; (b) Norwegian-born with foreign-born parents; (c) Norwegian born with one or more Norwegian-born parent; and also analysed foreign-born persons from the 25 birth countries with more than 10,000 residents in Norway compared to all Norwegian-born persons (regardless of parental birth country). Linear regressions were used to estimate the following models: (a) unadjusted; (b) age, sex; (c) age, sex, municipality of residence (base model); (d) base model plus occupation; (e) base model plus household crowding; (f) base model plus education; (g) base model plus household income; (h) base model plus medical risk for hospitalisation with COVID-19; and (i) all factors. We studied the period 15 June 2020 to 31 March 2021, excluding the first wave due to limited test capacity and restrictive test criteria.

Table I. Numbers of confirmed cases with SARS-CoV-2 and related hospitalisations by country of birth.

Country of birth	No. of cases	Cases per 100,000	No. of hospitalisations	Hospitalisations per 100,000	*N*	Estimates from model adjusted for all factors (robust standard error)	
						Cases per 100,000	Hospitalisations per 100,000
Norway	53,890	1175	1741	37	4,582,626	1276 (5.60)	39 (1.00)
with Norwegian-born parent(s)	44,315	1011	1647	37	4,383,108	1153 (5.41)	39 (0.995)
with foreign-born parents	9575	4799	94	47	199,518	3975 (48.36)	53 (5.34)
Outside of Norway	28,642	3140	1347	147	912,043	2636 (19.07)	139 (4.21)
Afghanistan	1118	6407	59	338	17,449	5303 (184.60)	335 (44.00)
BA-XK-HR-ME-RS-SI	1613	4087	95	240	39,462	3389 (99.00)	223 (24.60)
China	114	855	<5	<37	13,323	392 (80.20)	35 (15.10)
Denmark	295	1132	15	57	26,051	1134 (65.50)	35 (14.90)
Eritrea	1272	5669	36	160	22,437	5011 (154.50)	177 (27.00)
Ethiopia	508	4712	30	278	10,780	3810 (203.10)	267 (50.70)
Germany	325	1078	14	46	30,127	1109 (59.60)	46 (12.50)
India	433	2465	33	187	17,563	1918 (117.40)	175 (32.90)
Iran	754	3932	50	260	19,174	3183 (139.70)	235 (36.80)
Iraq	1711	7397	104	449	23,130	6319 (171.00)	421 (43.90)
Latvia	153	1293	<5	<42	11,829	1130 (104.70)	43 (15.00)
Lithuania	623	1444	7	16	43,139	1246 (59.30)	34 (6.90)
Pakistan	2042	9173	200	898	22,259	7562 (192.80)	819 (63.00)
Philippines	490	1855	24	90	26,412	1416 (83.10)	94 (18.70)
Poland	3163	2954	55	51	107,054	2534 (52.20)	52 (7.40)
Romania	409	2487	13	79	16,442	2168 (122.00)	86 (22.00)
Russia	746	3948	44	232	18,894	3693 (140.50)	241 (35.10)
Somalia	2395	8477	108	382	28,250	7056 (166.20)	353 (36.70)
Sweden	877	1738	15	29	50,449	1382 (58.30)	13 (7.90)
Syria	1415	4219	56	166	33,535	3569 (110.00)	191 (22.50)
Thailand	350	1470	18	75	23,797	1329 (78.70)	97 (18.00)
Turkey	705	5067	56	402	13,913	4246 (184.70)	376 (53.70)
UK	273	1237	10	45	22,056	1179 (74.60)	34 (14.40)
US	251	1185	<5	<24	21,179	1108 (74.60)	6 (8.30)
Vietnam	309	2086	34	229	14,813	1318 (117.10)	193 (39.30)

BA-XK-HR-ME-RS-SI: Bosnia and Herzegovina, Kosovo, Croatia, Montenegro, Serbia and Slovenia.

Estimates from full model shown (age, sex, municipality of residence, occupation, household crowding, education, household income, medical risk). Absolute numbers with fewer than five observations shown as <5, and the corresponding rate per 100,000 is calculated accordingly.

Results

The sample comprised 5.49 million persons, of which 0.91 million were born outside of Norway, there were 82,532 confirmed cases and 3088 hospitalisations (Table I). Norwegian-born to foreign parents (*N*=199,518) had the highest infection rates, and higher hospitalisations than Norwegian-born to Norwegian-born parent(s). Persons born outside of Norway had the highest rates of hospitalisations. There was large variation between different country backgrounds. Infection rates were highest among persons born in Pakistan, Somalia and Iraq; and lowest for China, Germany and Denmark. Hospitalisations were highest for Pakistan, Iraq and Turkey; and lowest for US, Lithuania and Latvia.

There was large variation in the distribution of the socioeconomic factors and medical risk factors included by country of birth (Figure 1). Foreign-born persons were more likely to live in crowded housing, have lower education and household income. Except for Pakistan, persons born outside of Norway were less likely to have a medical diagnosis associated with severe COVID-19. For some variables, we only had access to data until 2018 (household crowding, education) or 2019 (household income). Missing data were therefore higher among persons born outside of Norway, who may have immigrated after these dates. Missing: household crowding (*N*=405,642), 16.1% foreign-born versus 5.7% Norwegian-born; household income (*N*=242,299), 10.8% versus 3.1%; and for education (*N*=198,781), 19.1% versus 0.5% had no or undeclared education (ages >25 years).

All factors studied were each associated with infection and/or hospitalisation with COVID-19 among both Norwegian-born and foreign-born persons. When all socioeconomic and medical factors were added to the base model (age, sex, municipality of residence), excess infection rates were attenuated by 12.0% and hospitalisations by 3.8% among foreign-born, and 10.9% and 46.2%, respectively, among Norwegian-born with foreign parents,

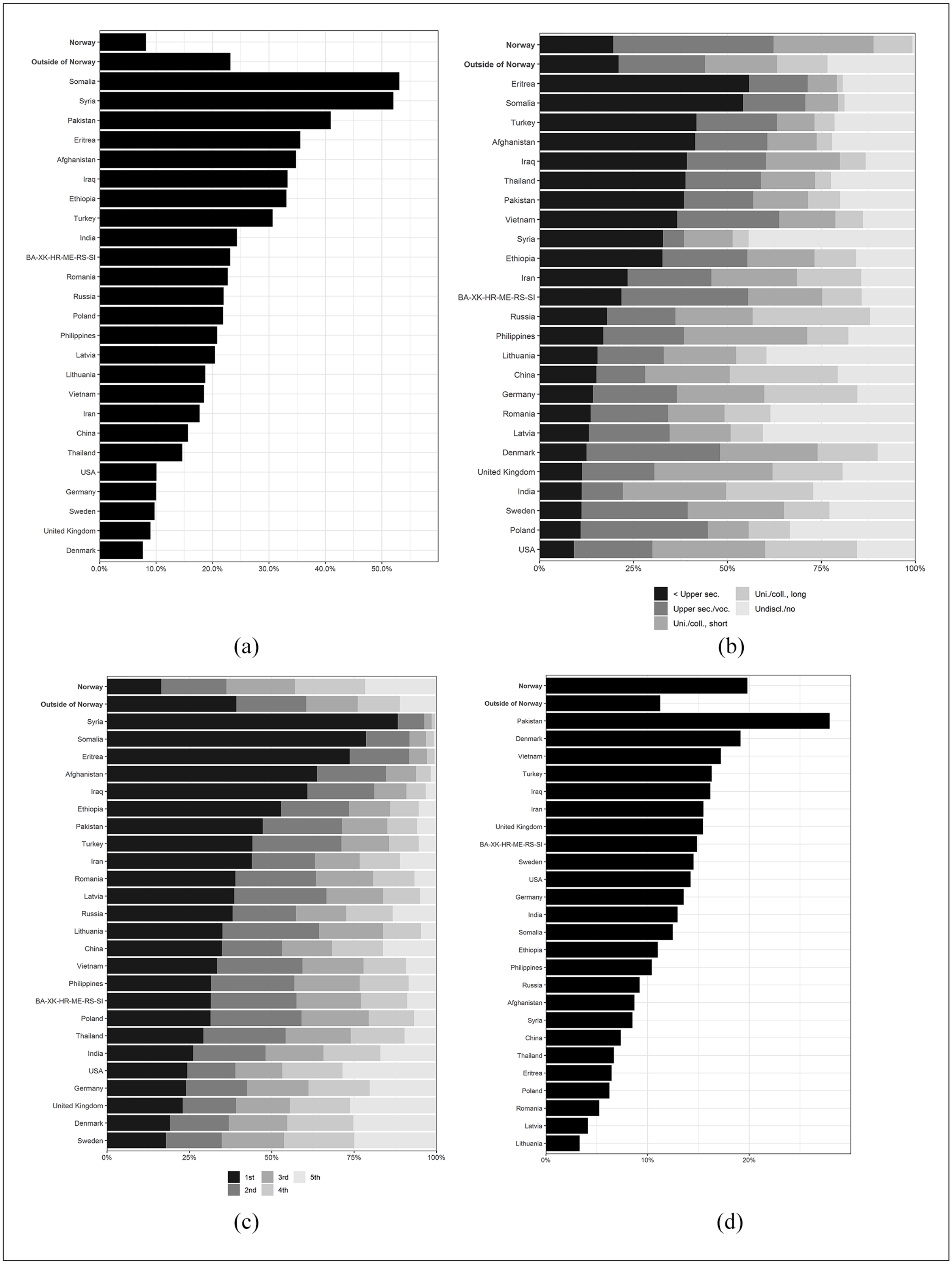

Figure 1. Distribution of socioeconomic factors and medical risk by country of birth. (a) Proportion living in crowded housing in 2019. (b) Highest completed education in 2019. (c) Equivalised household income (quintiles) in 2018. (d) Proportion with at least one medical risk diagnosis group.

compared to Norwegian-born with Norwegian-born parent(s) (Table II). In total, the full model attenuated excess infections compared to Norwegian-born with Norwegian-born parent(s) by 30.3% among foreign-born, and by 25.5% among Norwegian-born with foreign-born parent(s), compared to unadjusted estimates.

The same models were estimated for each of the 25 specified birth countries (reference category: Norwegian-born), see Table I (last columns) and Figure 2. While there was some variation in the relative significance of the different covariates between countries, no model changed estimates substantially (Figure 2). The addition of socioeconomic factors (occupation, household crowding, education, household income) to the base model reduced excess infections somewhat; however, the base model generally resulted in the largest reductions for all groups (Figure 2(a)). Estimates for hospitalisations were less certain due to small numbers, but no adjustments gave substantial differences (Figure 2(b)).

Various sensitivity analyses were performed, including the number of people in the household in addition to the household crowding variable, and use of logistic regression models instead of linear. The main results were robust to these sensitivity analyses.

Discussion

Although factors related to social inequality were risk factors for infection and/or hospitalisation with COVID-19 among both foreign-born and Norwegian-born persons, these factors only partially explained the differences across country backgrounds. One of the most likely explanations for the high hospitalisation rates in many of the groups is a correspondingly high infection rate (detected and undetected) [16]. This is supported by high test positivity rates in many of the same groups with high hospitalisations [16], which may indicate persistent and extensive undetected infections in the immigrant population. Hospitalisation with COVID-19 is likely to be the best indication of the true levels of infection because it is independent of test activity, assuming that hospital capacity is maintained, and patients have good access to hospitals.

There is little existing research on the role socioeconomic factors play in COVID-19 infections and hospitalisations among immigrants or minority ethnic groups, and our study complements existing reports. Our findings are in keeping with a new Danish report on COVID-19 infections among immigrants, grouped into 'western' and 'non-western' origin, adjusted for socioeconomic factors [17]. Our findings are somewhat more modest than a UK study [2], which found that adjustment for socioeconomic and lifestyle factors and comorbidities attenuated excess hospitalisations by 33% for Blacks and 52% for Asians. However, that study used ethnic categorisations while our data are by country of birth so direct comparisons are not possible. Moreover, the migration patterns to Norway and the UK differ, although in both countries migrants are overall younger than the general population and rate their health as good [13, 18]. The modest attenuation we find may reflect that there are relatively fewer disparities in the Norwegian setting with strong social welfare rights and universal healthcare for all residents, including all registered immigrants. Despite this, there may still be barriers to accessing health services for migrants in Norway. Research suggests that, overall, immigrants in Norway use primary and secondary healthcare services slightly less than the general population; however, there is great variation by country of origin [13]. Nevertheless, our findings are in keeping with existing research that on the whole indicates that socioeconomic factors only partially attenuate disparities with regard to COVID-19 among ethnic minorities [1, 5, 14, 15].

Large cities often have large proportions of immigrants, and urban living could be a factor in the spread of COVID-19 [19]. Oslo has the highest proportion of residents with immigrant background and the highest notification rates of COVID-19 in Norway. Our analyses show that municipality of residence had the highest explanatory power for both infection rates and hospitalisations; however, foreign-born persons had higher rates both in and outside of Oslo [10].

Immigrants often work in service-based occupations with close contact with others. However, a Norwegian study [20] found that immigrants from Somalia, Pakistan, Iraq, Afghanistan and Turkey, working in occupations with high contact frequency, did not have higher infection rates than others with the same country of birth, but did have higher rates than Norwegian-born with the same occupation. Networks related to the immigrant group therefore seem to be more important than the occupational network in explaining increased infection rates.

In some immigrant groups there might be a tradition for closer family ties, including between generations, than is common in Norway. The high infection rates we see among Norwegian-born with foreign-born parents may indicate that much of the infection occurs within family and social environments that are connected to the parents' country of birth. Because the virus spreads exponentially if no measures are implemented, even small increases in

Table II. Confirmed cases with SARS-CoV-2 and related hospitalisations.

Country of birth	(1) Unadjusted	(2) Age, sex	(3) Base model: age, sex, municipality of residence	(4) Base model + occupation	(5) Base model + household crowding	(6) Base model + education	(7) Base model + household income	(8) Base model + medical risk group	(9) All factors
Cases									
(A) Norway, Norwegian-born parent(s)	1011 (4.78)	1038 (4.91)	1107 (5.14)	1114 (5.17)	1138 (5.23)	1106 (5.26)	1129 (5.24)	1107 (5.14)	1153 (5.41)
(B) Norway, foreign-born parents	4797 (47.83)	4839 (49.34)	4273 (48.63)	4263 (48.61)	4054 (48.42)	4255 (48.63)	4147 (48.51)	4273 (48.63)	3975 (48.36)
(C) Foreign-born	3140 (18.26)	3002 (18.35)	2793 (18.21)	2764 (18.26)	2691 (18.15)	2801 (19.09)	2716 (18.38)	2792 (18.20)	2636 (19.07)
Percentage change in excess cases from base model, group (B) vs. (A)			Ref.	−0.54	−7.90	−0.54	−4.67	0.00	−10.87
Percentage change in excess cases from base model, group (C) vs. (A)			Ref.	−2.14	−7.89	0.53	−5.87	−0.06	−12.04
Hospitalisations									
(A) Norway, Norwegian-born parent(s)	38 (0.93)	34 (0.87)	38 (0.95)	39 (0.97)	38 (0.96)	38 (0.97)	39 (0.97)	38 (0.94)	39 (0.995)
(B) Norway, foreign-born parents	47 (4.86)	88 (5.28)	64 (5.23)	63 (5.22)	58 (5.31)	62 (5.23)	54 (5.27)	64 (5.23)	53 (5.34)
(C) Foreign-born	148 (4.02)	157 (4.17)	142 (4.06)	137 (4.05)	142 (4.09)	143 (4.22)	139 (4.06)	142 (4.05)	139 (4.21)
Percentage change in excess hospitalisations from base model, group (B) vs. (A)			Ref.	−7.69	−23.08	−7.69	−42.31	0.00	−46.15
Percentage change in excess hospitalisations from base model, group (C) vs. (A)			Ref.	−5.77	0.00	0.96	−3.85	0.00	−3.85

Adjustments for age, sex, municipality of residence, occupation, household crowding, education, household income and medical risk group for severe disease. Numbers per 100,000 (robust standard errors in parentheses).

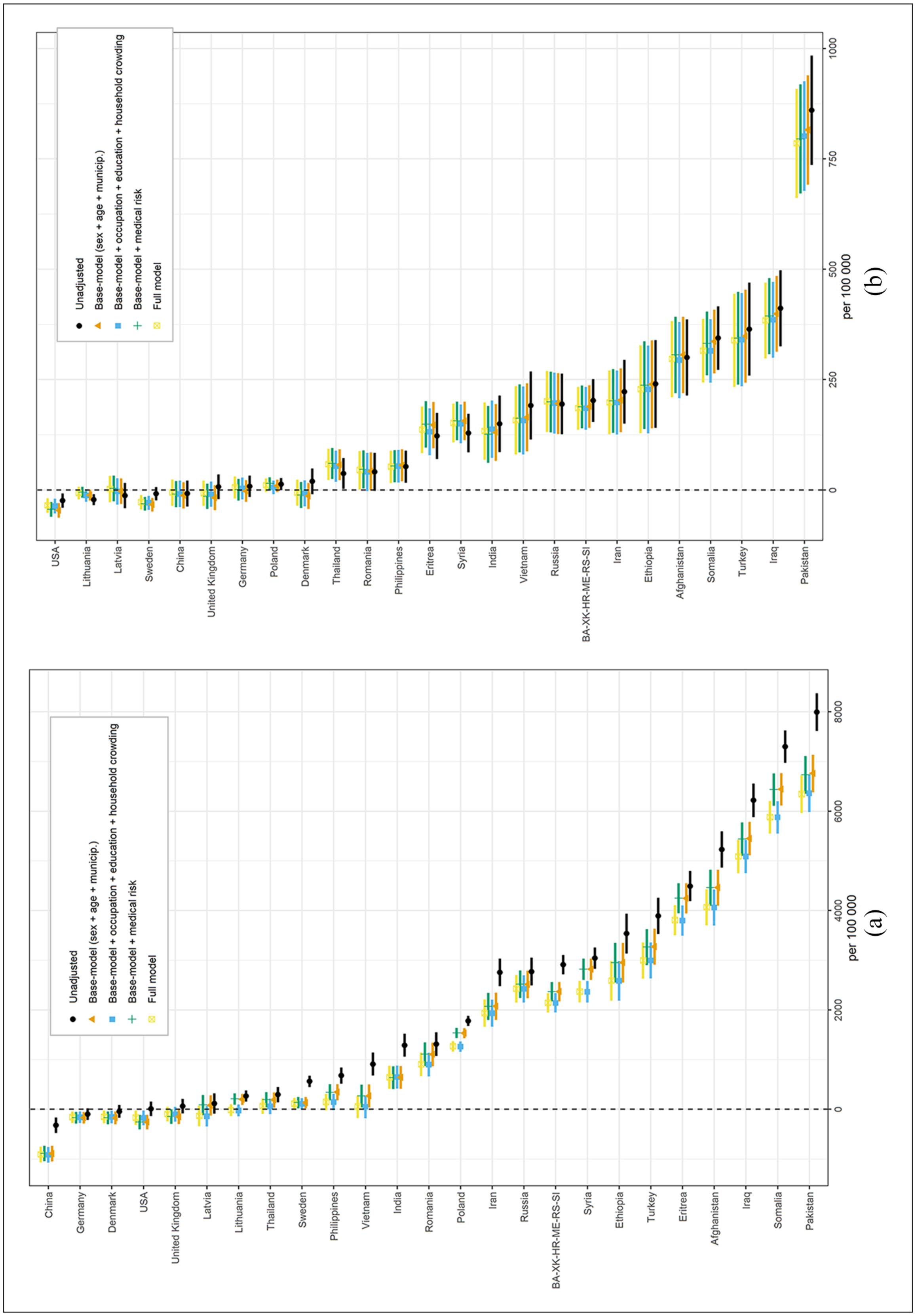

Figure 2. (a) Confirmed SARS-CoV-2 cases and (b) hospitalisations per 100,000 persons, by country of birth for countries with more than 10,000 residents in Norway (N=5,256,143). Models shown: (1) unadjusted; (2) base model (age, sex, municipality of residence); (3) base model plus socioeconomic factors (occupation, household crowding, education, household income); (4) base model plus medical risk (14 diagnosis groups); (5) full model (age, sex, municipality of residence, occupation, household crowding, education, household income, medical risk). Reference category (dotted line): Norwegian-born. Bars indicate robust standard errors. BA-XK-HR-ME-RS-SI: Bosnia and Herzegovina, Kosovo, Croatia, Montenegro, Serbia and Slovenia.

infection risk within a group of the population can quickly become significant if the group, due to strict regulations during the pandemic, has limited its social contact to people within its own group. Infection tracing data indicate that much of the spread occurs within families, and we find that household crowding is associated with infection regardless of country background. However, this variable, at least as it is defined, explains little of the increased infection rates among immigrants. It may be that it is difficult to stop the spread of infection within households regardless of crowding. More knowledge is needed as to how household factors affect the spread of infection, such as household composition, number of residents, multigenerational living, and housing type.

Some immigrants have strong family ties to countries with relatively high infection rates, and may travel relatively more due to important family or financial commitments. Available data from people arriving in Norway between 10 and 20 March, 2021 indicate that the proportion who test positive within 10 days of entry is relatively high, especially from Asia (5.3%) and Africa (2.7%) [21]. However, it is uncertain how comprehensive and correct these data are, as they are based on self-report and not all data were able to be linked to relevant registers.

Several studies have examined the role of genes for SARS-CoV-2 susceptibility and COVID-19 disease progression. The findings are so far somewhat heterogeneous [22–24]. Our data material does not allow the study of genetic associations with differences in infection rates and disease severity. We observed both increased infection rates and hospitalisations for a wide range of country backgrounds. COVID-19 is likely multifactorial, with many genetic and non-genetic factors influencing host response to SARS-CoV-2 exposure. A major challenge going forward will be to identify the critical factors and their co-action in determining disease progression. Our study helps to illuminate how socioeconomic and medical risk factors account for differences between groups of immigrants in Norway, but it also highlights that the factors we have studied do not fully account for the overrepresentation of some of these groups.

Our study includes the entire population of Norway, uses individual-level data, and allows the study of individual country backgrounds to understand better the heterogeneity behind broad ethnic categories. However, the data used in our analyses only capture formally registered information. There are several factors that indicate that our estimates should be interpreted with caution; however, the main findings should still hold. Foreign-born persons were more likely to have data missing for several variables. This may have contributed to poor explanatory power. Reasons for missing data among foreign-born include migrating after 2018/2019, when data on income, housing and education are from, and that education obtained outside of Norway is not necessarily registered in the national registers. Systematic biases in seeking medical help may affect registration of diagnosis codes on which medical risk groups are based. Barriers to and use of health services among immigrants have previously been discussed, and if systematic biases do exist, medical risk among foreign-born will be underestimated in this study. However, a large study from the UK found that disproportionately high COVID-19 deaths among ethnic minorities were only partially reduced after adjustment for medical risk conditions in addition to socioeconomic status [15].

The overrepresentations we observed among foreign-born and their children were likely to be due to a combination of several factors that act in combination, and many of which may be difficult to measure. For example, differences in travel patterns, how well the test-trace-and-quarantine strategy works in different groups, how infection spreads within a social environment, and interactions between different factors. Language barriers, low health literacy, vulnerable working conditions, and concerns about loss of income for those without the right to sick pay can all be barriers to testing, quarantine and isolation. Persistently high infection rates in some districts or municipalities may have led to a situation in which high workload creates delays in contact tracing, in turn resulting in chains of infection not being broken. Although much has been done to adapt, translate, and disseminate information to the immigrant population, information about regulations and advice is complicated and in constant change. This can be challenging for all, let alone for people who do not master the local language.

Conclusions

Residents with foreign backgrounds have, as a group, been disproportionately hit by COVID-19 in Norway. Adjustment for socioeconomic factors and medical risk attenuates the overrepresentation moderately; however, the overall picture remains the same. The data available or variable definitions may not have fully captured the effects and interactions of these factors, and future studies should aim to unravel this further.

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Author contributions

Thor Indseth, Anna Godøy and Kjetil Telle contributed to the study conception and design. Data analysis were performed by Ingeborg Hess Elgersma, Bjørn Heine Strand, Kjetil Telle and Anna Godøy. The manuscript was drafted by Angela S. Labberton. The original Norwegian-language report on which the manuscript is based was drafted by Thor Indseth. All authors contributed to the interpretation of results and revision of the report and manuscript. All authors read and approved the final manuscript.

Availability of data and material

The datasets analysed in the current study are not publicly available due to privacy laws. Individual-level data for research are generally available within Norway on application conforming with strict regulations and procedures.

Consent to participate

The study was based on deidentified data from BeredtC19 and no consent was required. No patients were involved in setting the research question, study design, outcome measures, or the conduct of the study.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval

In addition to institutional board review, the ethics committee of South-East Norway confirmed that external review for BeredtC19 was not necessary (4 June 2020, no. 153204). In addition, a study protocol, which in part also covers the current work, was granted approval by the ethics committee of South-East Norway (9 March 2021, no. 198964).

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ORCID iDs

Angela S Labberton https://orcid.org/0000-0002-0047-7103
Thor Indseth https://orcid.org/0000-0002-2727-332X

Supplemental material

Supplemental material for this article is available online.

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